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Air Conditioning Service and Diagnosis

Subject Page

Air Conditioning Service and Diagnosis

Model: All

Production: All

OBJECTIVES

After completion of this module you will be able to:

- Understand the precautions that need to be observed when working on a climate control system.
- Identify the tools and equipment necessary to work on BMW Climate Control Systems.
- Describe the different service procedures necessary to service a BMW Climate Control System.
- Identify some of the most common A/C system scenarios.

Safety Requirements

Product Properties

Although R134a is non-toxic, non-flammable and not explosive with air in any mix ratio at normal temperatures, various safety measures must still be observed. The filled refrigerant circuit is pressurized. The refrigerant must be extracted when performing repairs on the air conditioning system. As a gas, R134a is colorless, odorless and heavier than air. The various refrigerants that are used in vehicle air conditioning systems belong to the substance class of the new generation of refrigerants based on chlorine-free, partly fluorinated hydrocarbons (H-FCs, R134a).

With regard to their physical properties, these are refrigerants that condense under pressure. They are subject to the pressure vessel ordinance and must be filled only in approved and correspondingly identified pressurized gas containers. Specific requirements that must be adhered to apply to their safe and correct use.

Handling Refrigerant

After opening refrigerant containers, the content can escape in liquid or vapor form. The higher the pressure in the container the more intense the reaction. The pressure level depends on two conditions:

- What type of refrigerant is in the container? The lower the boiling point, the higher the pressure.
- How high is the temperature? The higher the temperature, the higher the pressures.

Wear Safety goggles!

Wear safety goggles. They prevent refrigerant from entering the eyes and possibly causing serious damage due to its freezing effect.

Wear protective gloves, do not allow liquid refrigerant to make contact with the skin!

Refrigerants effectively dissolve greases and oils. They therefore remove the protective oily layer when they come in contact with the skin. Skin without the protective oily layer is sensitive to low temperatures and susceptible to illness causing germs.

When it evaporates, the refrigerant absorbs heat from the environment even if this is human skin. Very low temperatures can be reached, resulting in local frostbite (boiling point of R12 = -30°C, R134a -26.5°C).

Do not inhale refrigerant vapors in higher concentrations! Leaking refrigerant vapors mix with the ambient air and displace the oxygen necessary for breathing. The workstations must be well ventilated if refrigerant escapes in higher concentrations. *Immediately seek medical assistance if problems occur after inhaling refrigerant vapors!* Rooms must be sufficiently ventilated or switch on extractor system if available.

No Smoking!

Refrigerants can break down in the heat from cigarettes. The resulting substances are toxic and must not be inhaled. Avoid welding and soldering on filled air conditioning systems! Before welding and soldering on air conditioning systems, the refrigerant must be extracted and residue removed by blowing out the system with nitrogen.

The decomposition products produced when the refrigerant is subject to the effects of heat are not only toxic but are also very corrosive, affecting pipes and system components. The corrosive substances are essentially hydrogen chloride and hydrogen fluoride. The presence of these decomposition products is associated with a pungent odor. Under no circumstances must these substances be inhaled as they can damage the respiratory tract, the lungs and other organs.

First Aid!

1. In the event of contact with the eyes, flush out with plenty of flowing water and seek medical assistance.
2. In the event of contact with the skin, immediately remove soaked clothing and flush skin with plenty of water.
3. If refrigerant vapors in high concentrations are inhaled make sure the person affected is immediately brought out into the fresh air. Seek medical assistance. Provide oxygen if breathing difficulties occur. If the person affected suffers breathing difficulty or is no longer breathing, tilt back the head and perform CPR.

Handling PAG Oil

- Do not store in the vicinity of flames, heat or oxides
- Avoid contact with the eyes
- Do not inhale (vapors)
- Avoid prolonged or repeated skin contact

First Aid Measures:

- After inhalation: Take the person into the fresh air and seek medical assistance.
- After skin contact: Wash thoroughly with soap and water.
- After eye contact: Flush thoroughly with water.
- After swallowing: Seek medical assistance. Do not induce vomiting.

Important Service Information

- Store all spare parts in a dry place and keep locked.
- When installing parts, only remove the plugs just before installation. This requirement applies particularly to the dryer. A dryer that is not sealed can absorb moisture, rendering it unusable. Immediately close off open pipes with plugs when performing repairs on the refrigerant circuit.
- Keep empty refrigerant bottles closed.
- Acquire refrigerant only through BMW Parts Service or specialized trade.
- Do not perform repairs in the open under moist weather conditions.
- Replace the dryer following intervention (repair) in the refrigerant circuit if it was left open for longer than 24 hours or there was a leak in the air conditioning system.
- Do not use refrigerant oil from open containers.
- Moisture in the refrigerant circuit not only diminishes the cooling capacity but also oxidation can cause soiling of the air conditioning system, resulting in expensive repairs and down-time.
- Evacuate the refrigerant circuit before placing it into operation. Additional drying can be achieved by interrupting the evacuation process and flushing with refrigerant or blowing through with nitrogen (if available) prior to initial operation. This procedure can increase the cooling capacity again if it was diminished as the result of moisture.
- In warranty cases, plugs must be fitted on the old parts in order to be able to determine the cause of the damage.

Refrigerant Circuit

The following points must be observed when working on the refrigerant circuit:

- Extract all the refrigerant before opening the refrigerant circuit.
- After extracting the refrigerant, measure and replace the quantity of oil also extracted.
- Replenish the prescribed quantity of oil (specified in TIS) when replacing components.
- First evacuate the system for at least 30 minutes before refilling the circuit with refrigerant.
- Always replace the liquid reservoir (dryer) if there is a leak in the system or it was opened for longer than 24 hours during repair.
- Always replace the seals of the connections that were opened and wet with oil prior to assembly.

Compressor Service

- When troubleshooting a noisy compressor complaint, make sure the noise is present only when the clutch is engaged.
- If it is present when the clutch is not engaged, remove the compressor drive belt and check again.
- If the noise continues, it is not related to the compressor.
- If removing the drive belt reduces or eliminates the noise, check the torque of the compressor and bracket mounting bolts.
- Check the belt tension and condition, and tensioner pullies which can produce rattling noises that would sound like a defective compressor.
- A loose/slipping belt can cause noise.
- A belt that is too tight can damage the clutch bearings.
- If the compressor is noisy with the compressor clutch engaged, make sure the system is charged with the correct amount of refrigerant.
- An over-charged system can cause compressor noise.
- If the A/C system is overcharged with refrigerant, the liquid entering the compressor can damage it.
- When troubleshooting a noisy compressor complaint, recover the refrigerant and recharge the system with the correct amount.
- A failed compressor must be returned with the inlet and outlet ports sealed using the plastic caps from the replacement compressor. Otherwise the “failed” compressor will be damaged by moisture, and it will be impossible for Warranty to analyze it.

Compressors with plastic pulley:

- Avoid impact on the plastic pulley (through tools, contact with base).
- Send back damaged compressors only in original packaging.

Note: After replacing compressor It is important to perform the following running-in procedure when operating a new compressor for the first time.

- Switch off air conditioning system.
- Set all air outlet nozzles on the instrument panel to "OFF".
- Start engine and allow idle speed to stabilize.
- Set blower capacity to min. 75% of the maximum blower capacity.
- Switch on air conditioning and allow to run for at least 2 minutes at idle speed. Risk of damage at higher speed! (Refer to DIS Service Functions for more detailed instructions)

When extracting the refrigerant from the air conditioning system, the refrigerator oil is also removed and collected in the oil separator of the service station.

Following extraction, the refrigerant in the service station must be cleaned as there still may be a liquid refrigerant-oil mixture in the oil separator. The cleaning procedure fully evaporates the refrigerant leaving only the refrigerant oil previously collected in the oil separator. Measure and note down this quantity of refrigerator oil.

Note: For details on compressor replacement, see the TIS, Group 64

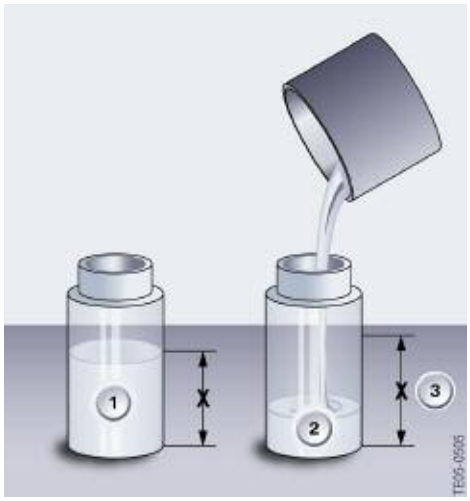
Refrigerant Oil Service Procedure

Empty the refrigerant oil remaining in the old compressor via the filler plug into a measuring beaker.

Measure the collected quantity of refrigerant oil from the old compressor.

Depending on the version, the new compressor is filled with 120 to 200g of refrigerant oil at the factory.

Open the filler plug and fill the entire content of the (new) compressor into a clean container.
Replace seal if necessary.

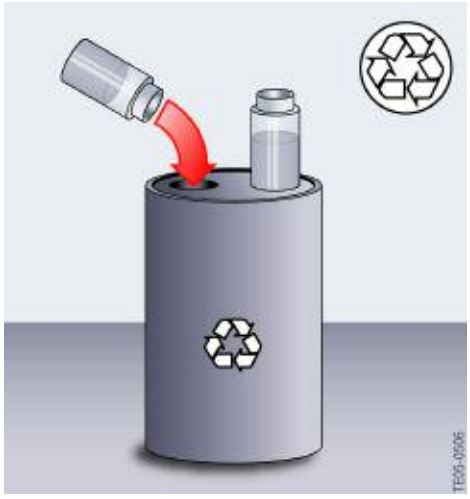


Using only new refrigerant oil, fill the same quantity as extracted from the old compressor + 10g safety amount into a clean measuring beaker and refill the new compressor.
The remainder of the new refrigerant oil can be filled into the reservoir of the service station. Otherwise, the surplus refrigerant oil must be disposed of correctly.

1 = Old

2 = New

3 = Old + 10 g



The refrigerant oil extracted from the oil separator of the service station and from the old compressor must not be reused and must be disposed of correctly.

Note: For refrigerant oil capacities refer to TIS Operating Fluids Section under group 64 for Air Conditioning and Heating.

NOTES PAGE

Tools and Equipment

There are a variety of tools and equipment used for the correct handling, service and diagnosis of the AC system:

- Temperature Sensing Tools
- Recycling/Charging Equipment
- Refrigerant Leak Detectors

Temperature Sensing Tools

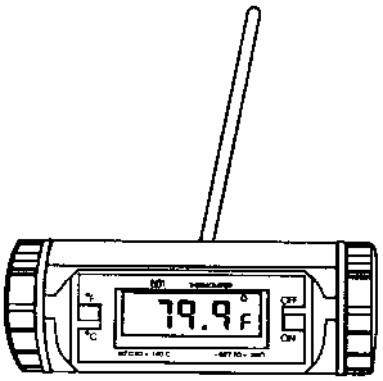
The correct way to service and diagnose a climate control system relies heavily on the ability to accurately measuring the systems temperature output. To know the ambient temperature and humidity is as important as the output temperature of the system, because these are linked together as showed in the chart on the previous page.

Thermometers

The most inexpensive and popular among technicians is the typical pocket thermometer. Similar to a meat thermometer it has a flat gauge (mechanical and digital) with a long sensing stem on the other end. Because of its design it is convenient to introduce it into outlet vents on the vehicle.

Typical Use: A/C Performance Quick Check

Test conditions = 90°F & 50% Humidity



- Note ambient temperature
- Close all windows and doors
- Engine Speed = 1500-2000 RPM
- Blower Volume = Medium Speed
- Temperature Wheel = “Max Cold”
- “Snowflake” Button = A/C On
- Test conditions > 3 minutes
- Center vent discharge = 20°F less than the ambient temperature.

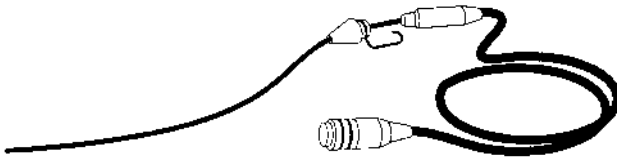
Diagnostic Equipment Temperature Probe

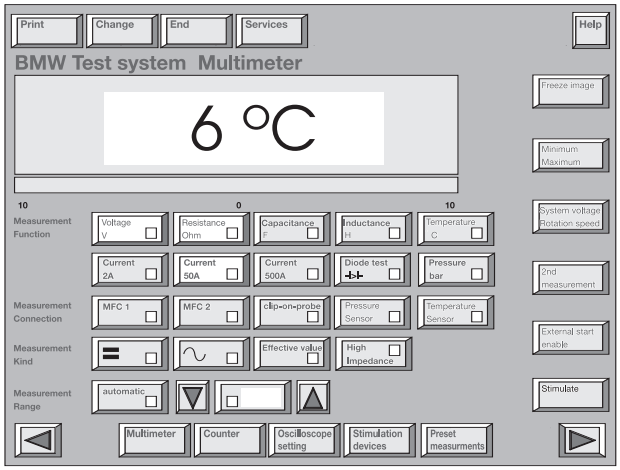
The Diagnosis and Information System (DIS) and GT1w/MIB (Measurement Interface Bos) testers are equipped with a temperature sensor cable, stored in the compartment at the rear of the tester. It can be used to measure the temperatures of liquids and gasses from -20° to 200°C.

To use the DIS/ GT1 as a thermometer:

- Select “Measurement System” button on the DIS start screen.
- Select “Temperature C” button on the “Measuring System Multimeter” screen.

Diagnostic and Information System DIS Shown





Pyrometer

A pyrometer is a non contact, point and shoot measuring tool.

The typical design uses a laser aimed device that consists of a lens to focus the infrared (IR) energy on to a detector, which converts the energy to an electrical signal that can be displayed in units of temperature after being compensated for ambient temperature variation.

Pyrometers are especially useful where other measuring tools have limitations, like testing thermostats, temperature sensors, radiator/ heater core flow, condenser efficiency, and hard to reach thermostatic expansion valves, evaporators.

Recycling/Charging Equipment

A proper system charging station includes the following components:

- A manifold gauge set.
- A charging cylinder.
- A bulk refrigerant supply tank.
- A vacuum pump.
- Hoses for connection to the automotive A/C system.
- An electronic leak detector.
- A thermometer.

This setup will allow you to evacuate and charge an A/C system. These units filter and remove moisture the refrigerant, before discharging it into a recovery tank.

Note: Refer to the operating instructions of the AC equipment you are working with for specific operating instructions.

Note: The refrigerant type must be identified prior to attempting any service on the vehicle, generally the refrigerant used is evident by the connections and by reading the label under the hood, but when in doubt a refrigerant identifier may be used.

Connecting Recycling/Charging Equipment to a Vehicle

The LOW side hose is BLUE in color and incorporates a quick disconnect type fitting (similar to an air line) along with a shut off valve so as to minimize refrigerant leakage.

The High side hose is RED in color and also incorporates a quick disconnect type fitting along with a shut off valve so as to minimize refrigerant leakage.

Refrigerant Recovery Process

Once the type of refrigerant has been identified, the recovery machine is plugged into a 110 ac volt power supply and connected to the vehicle. First, connect the hoses to the service fittings on the vehicle, then open the shut off valves. The gauges will show the system pressure on both the low and high sides. These pressures will vary depending on the type of vehicle you are working on and how much refrigerant remains in the system.

Now, power on the recovery/recycle machine and activate the recovery process. It is important to follow the operating instructions for the recovery equipment you are using since every machine is slightly different.

Once recovery begins, pressures will decrease as the refrigerant is removed from the system. The machine will empty the system and then pull it down to a vacuum state until all of the refrigerant has been recovered. When all the refrigerant has been recovered, the machine will automatically shut off. The shut off point is based off of vacuum pressure and is different depending on the equipment manufacturer.

If the system holds a vacuum for at least two minutes and never shows a positive pressure when the process has completed, then the refrigerant has been completely removed from the system. However, if pressures begin to creep up after the machine has stopped, and then there is still refrigerant trapped in the system. The recovery process has to be repeated to remove the remaining refrigerant. Once the refrigerant has been successfully recovered, close the shutoff valves and disconnect the recovery machine from the system.

Check the oil collection bottle and record the amount of oil that was removed during recovery, this amount you will add when recharging the system. The recovery stage is complete. The technician can now open the system and make any needed repairs. When all repairs are complete, the system can be recharged. You will learn about recharging the system later in this lesson.

Recycling Process

As refrigerant is removed from the air conditioning system during the recovery stage, it is drawn through a filter to remove dirt, oil, air and water. This allows for reuse of the refrigerant upon completion of the repair. The filter used for recycling the refrigerant needs to replace at a recommended service interval specified by the equipment manufacturer.

There is an oil separator on the recovery machine that removes oil from the refrigerant and stores it in a oil storage container. Record the amount of oil recovered to determine how much oil should be used for recharging. When recharging, the amount of oil is very important for proper operation of the system. Always check the manufacturer’s recommendations before adding any oil to the vehicle. This is especially true if the system has been opened or damaged prior to service.

Recharging Process

Before the A/C system can be recharged, the air, moisture and any contaminant's that may have entered the system during the repair must be removed. This is accomplished by pumping the system down to a vacuum, removing the air and debris from the system. To evacuate a system, regardless of the equipment being used, follow these guidelines:

- Connect the hoses of the recovery/recycling machine to the vehicle service fittings.
- Open both valves on the connectors.
- Now, activate the vacuum pump and run for a minimum of 30 minutes.
- Close both valves on the connectors and turn off the vacuum pump.
- Now, write down the gauge readings and let the vehicle sit for five minutes.
- Recheck the gauge readings and note the difference.
  - If the gauge readings differ more then 2” of vacuum in 5 minutes, then there is a leak in the system.
  - If the gauge readings change very little, then the system is ready to be recharged.

To determine the exact amount of refrigerant needed for the vehicle’s air conditioning system, locate the label under the hood. The label specifies the type and quantity of refrigerant the system requires. This vehicle label calls for 1.30 +/- 0.02 lbs of R134a.

Along with the refrigerant, oil has to be added back in the system. The machine collects the oil during the recovery process. Measure the oil you recovered, then add the amount of oil that normally collects in the components you replaced (if any). The resulting amount of oil is to be put back into the system.

- If you have replaced the condenser or evaporator, 2 additional ounces of additional oil must be added.
- If you have replaced the receiver dryer on a vehicle that uses the stand-alone type receiver dryer, you would add 1 additional ounce of oil.
- Hoses do not collect much oil so if just a hose was replaced, only the oil measured in the cup during recovery will be needed.

Follow the operating manual for the recharging equipment you are using to calibrate the correct amount of refrigerant in the machine. Then, following the operating manual, add the refrigerant to the A/C system.

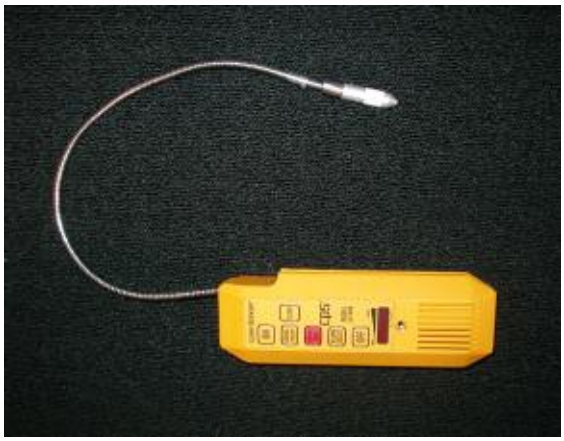
Refrigerant Leak Detectors

The two approved methods for leak testing an A/C system are a leak detector (sniffer) and by installing fluorescent dye into the system.

Sniffer Leak Detector

The sniffer leak detector is a device that has circuitry capable of detecting refrigerant leaks as small as 0.40 oz per year. A small internal motor draws in air through the tip of the probe and when refrigerant is detected, a lamp illuminates or a buzzer or audible beeper sounds depending on the type you are using. Leak detectors calibrated for R-134a will detect R-12, but leak detectors calibrated for R-12 will not detect R-134a.

Using a leak detector like this takes experience and practice. Many times an oily black dust collects on or around leaking component. This evidence of escaping oil and refrigerant and is a very good place to start.



A low-pressure side leak may only occur when the system is turned off because pressures are higher with the system off. The high-pressure side might leak when the system is ON for pressures are higher when the system is ON. It is always better, if you can, to check the system for leaks with it OFF. The cooling fan circulates the air in the engine compartment and makes it difficult to identify the leak.

The tip of the detector can be inserted in and around the suspected refrigerant leaks like between condenser fins or the outlet vents on the dash or in the water drain hose of the evaporator box to check for a leaking evaporator. A downside to using this method would be that in some shops the service area may be contaminated with different gasses that make the tool a somewhat difficult to operate.

Fluorescent Dye

To check for a leak with dye, the dye has to be added to the system and then monitored using an ultraviolet lamp and special safety glasses. When the ultraviolet beam of light shines on the suspected fluid, it illuminates with a yellow glow as evidence of the refrigerant leak. Caution must be observed when using the dye because it tends to stain everything it touches, so a special cleaning solution is supplied with the kit.

Note: Refer to SIB 04 14 04 “A/C Leak detection Kit” R-134a A/C dye leak tester has been approved for use on BMW Group vehicles.

The typical dye kit includes:

- UV protecting safety glasses
- 12 volt UV/blue 100W lamp
- A container of fluorescent dye
- Dye injector device
- Hose adapters
- Dye cleaner/remover
- Instructions

Leak Testing the A/C System

Always be aware of the safety measures associated with handling refrigerant as far as wearing eye protection, gloves and respiratory equipment. (Refer to Safety Section)

If the refrigerant leak was not identified during the evacuation, the system must be filled before it can be tested for leaks with either dye or the electronic leak detection device.

Some helpful hints to remember when using a Dye Leak Detector:

- It is better to check the Low Side for leaks with the A/C system off.
- The high Side is best checked for leaks with the A/C system on.
- Refrigerant is heavier than air. Therefore you must always test below the suspected lines, connections and components.
- Commonly used shop solvent fumes, wind and cooling fans may throw off your diagnosis.
- When using the dye method, keep in mind that dye stains and a leak inside the vehicle like an evaporator can damage the interior.
- Evaporator leaks are best diagnosed with an electronic leak detector in the vent outlets or pressure tested with Nitrogen.

Symptoms Diagnosis and Gauge Readings

Refrigerant Pressure

Refrigerant pressure is directly proportional to its temperature so as the temperature goes up so does the pressure and vice versa.

Refrigerant in the A/C system is provoked to change state from a liquid to a gas and back again. During every change of state heat is either absorbed or given away in the process. This thermodynamic property is put to use in the expansion valve to evaporator section (Low Side) and in the compressor to condenser section (High Side) of all A/C systems.

In the High side, dry, pressurized liquid refrigerant exits the receiver dryer and is made to pass through a metered orifice in the expansion valve on its way to the evaporator. It is here entering the Low side, that it quickly decompresses, expands and absorbs heat and humidity from the passenger compartment as it changes state (evaporating) from liquid to a gas. The low side pressure is directly proportional to the evaporator temperature (see temp/pressure chart for R-134a) and dictates its heat exchanging capabilities. Low side pressures should average 28 to 32 psi, that means that the actual pressure of a variable piston displacement compressor/TEV system can be between 15 and 45 psi at any given time.

Heat and humidity are carried away by the refrigerant gas which is then suctioned into the compressor where it is compressed, heated and pumped through the A/C system via the condenser. A flow of ambient air cools the condenser and the compressed, hot refrigerant gas changes state to a liquid once again, as it flows further along the condenser. Here the hot gas condenses into a “warm” liquid as It gives away its heat.

The high side pressure reading directly indicates the condenser cooling efficiency. Although High side pressures may vary between 150 to 300 lb. normally they should be about 2 to 2.5 times the ambient temperature. Depending on humidity, an outside temperature of 80°F should produce a pressure of 160 to 200 psi on the High side (see temperature/pressure chart for R-134a). When the High side pressure is way above the normal it may indicate that the condenser auxiliary cooling fan is not cooling the refrigerant sufficiently. Proper air flow across the condenser insures the efficiency of the entire system. The cooler the refrigerant is leaving the condenser the lower its pressure; consequently the lower the pressure of the refrigerant entering the evaporator the more heat can be absorbed from the passenger compartment.

Note: Pressure gauges are indispensible when diagnosing A/C system BUT they are incapable of measuring the quantity or for that matter the type of refrigerant in the system.

A/C Performance Efficiency Test

Before an A/C efficiency test, satisfy the following conditions:

- Connect the diagnostic equipment and check for faults (no faults in the fault memory).
- Use a thermometer with separate gauge.
- Perform the test in a suitable work bay with an ambient temperature between 20°C and 30°C (68°F and 86°F).

Pre-conditions

1. Connect BMW diagnostic equipment to the vehicle and display evaporator temperature.
2. Position a (pocket) thermometer with a separate gauge about 5 cm(2 in.) below the roof liner at the height of the B-pillar. Lay the gauge facing outside of vehicle interior.
3. Heating up the vehicle interior:
   - A/C button is not activated during heating up.
   - Close all windows and doors.
   - Set recirculated air mode.
   - Select air distribution mode for footwell and defrosting.
   - Maximum temperature setting.
   - Maximum fan stage.
   - Run engine at approx. 2000 rpm until operating temperature is reached, then idle speed.

A/C Efficiency Test

- Turn on A/C compressor at a vehicle interior temperature of 50°C.
- After 3-4 minutes, the evaporator sensor temperature must be 15°C (59°F) or below.

If this temperature is not reached:

- Measure the amount of refrigerant collected.
- Recycle the refrigerant in the A/C system.

If the recovered refrigerant quantity does not correspond to the specified fill quantity:

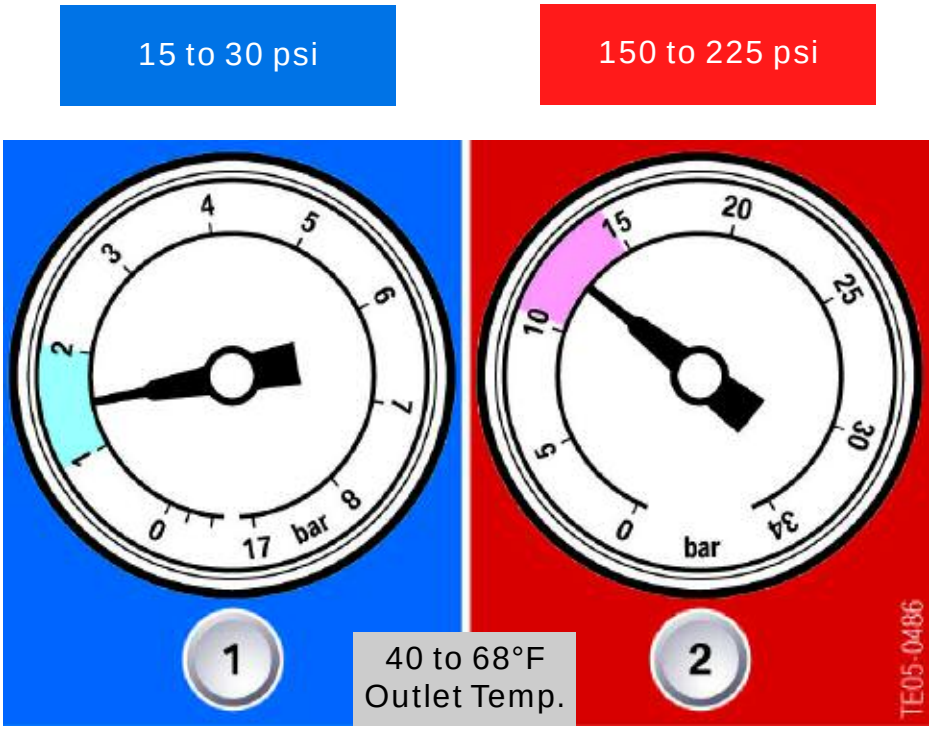
- Recharge with the specified amount of refrigerant and repeat test. If fill quantity is correct, continue troubleshooting by pressure measurement.

If fill quantity is correct:

- Continue troubleshooting by refrigerant pressure readings.

Note: For A/C systems with uncontrolled compressors only; if necessary, then continue troubleshooting by pressure measurement.

Normal Operation Readings



Index	Explanation
1	Low pressure - normal 1 to 2 bar (15 to 30 psi)
2	High pressure - normal 10 to15 bar (150 to 225 psi)

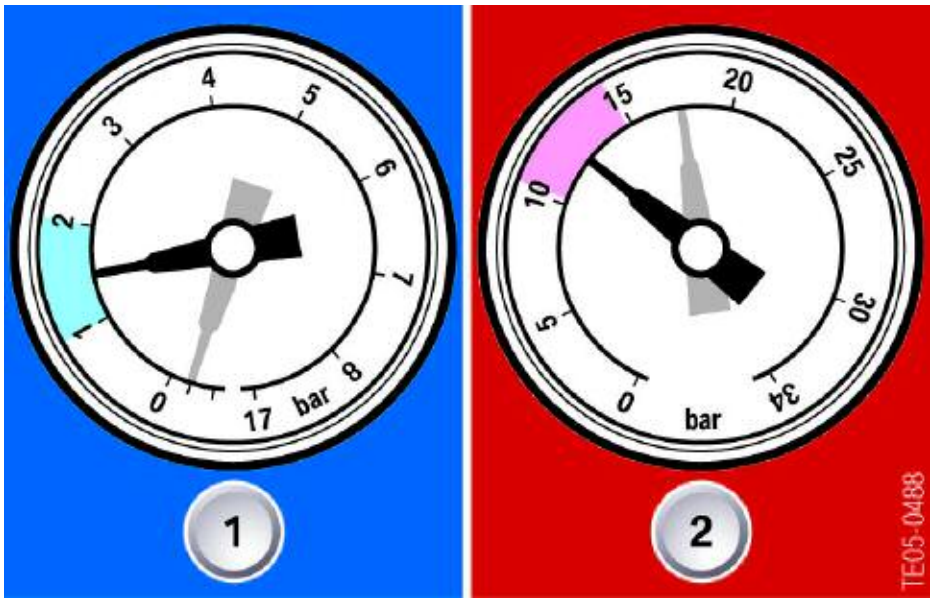
Outlet temperatures may vary from 40 to 68°F at any given time depending on ambient temperature and humidity. Readings of about 20° less than ambient temperatures are considered acceptable. Several fault symptoms involving high pressure and low pressure are described in the following examples, together with possible corrective measures.

Note: Refer to S.I.B. # 641392 (3646) or the chart on the following page for nominal air conditioning system pressures and temperatures for R12/R134a and the effects of ambient temperature and humidity on AC system performance.

Ambient Temperature/Relative Humidity Reference Chart

Relative Humidity (%)	Outside Air Temp (°F)	R-12 Discharge Temp(°F)	R-12 Low Pressure (psi)	R-12 High Pressure (psi)	R-134a Discharge Temp (F)	R-134a Low Pressure (psi)	R-134a High Pressure (psi)
20	70	44	24	143	44	9	69
	80	44	31	192	44	24	85
	90	50	45	232	47	40	136
	100	59	47	270	53	50	231
	110	66	57	320	64	58	308
30	70	44	23	154	44	10	80
	80	44	35	203	44	28	110
	90	54	47	239	48	42	168
	100	63	50	283	59	54	253
	110	74	60	334	69	62	328
40	70	44	34	170	45	12	93
	80	50	40	216	50	32	149
	90	58	48	146	56	45	212
	100	67	53	291	64	57	264
	110	77	63	350	74	67	348
50	70	46	37	178	45	14	102
	80	55	43	223	51	36	164
	90	61	50	252	59	54	229
	100	71	58	312	70	67	229
	110	84	66	365	80	76	368
60	70	47	40	187	45	18	133
	80	55	49	230	53	39	191
	90	64	54	266	62	57	249
	100	75	60	318	72	72	310
	110	86	68	383	83	80	384
70	70	47	41	228	46	19	168
	80	56	50	257	56	42	215
	90	66	56	278	67	61	260
	100	78	63	333	77	75	321
	110	91	72	402	87	87	390
80	70	47	43	247	46	21	178
	80	57	53	268	57	47	218
	90	69	62	287	69	67	267
	100	82	70	340	78	80	331
	110	95	76	438	90	89	405
90	70	48	44	258	46	33	183
	80	60	55	286	59	54	223
	90	72	63	307	71	69	274
	100	85	72	350	84	84	345
	110	101	80	463	87	94	424

Outlet Temperature Initially Cold then Warm



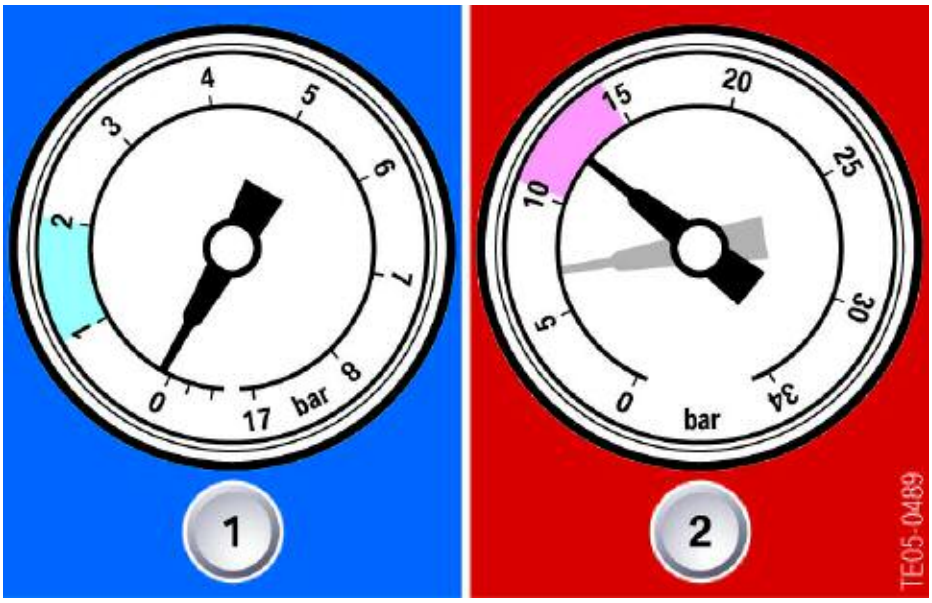
22 psi
to Vacuum

1 = Low pressure - normal to too low
2 = High pressure - normal to too high

160-260 psi

Symptoms	Possible faults	Repair
• Outlet temperature is initially cold but then warm • Evaporator/expansion valve partly ices up and then thaws again. • High pressure increases, low pressure drops to vacuum range. • Evaporator ices up before the compressor is switched off. • Slow compressor switching cycles.	Moisture in refrigerant circuit.	Recycle and Evacuate the system, replace the dryer and recharge.
	Temperature sensor for evaporator defective.	Check evaporator temperature sensor and replace if necessary.
	Faulty pressure sensor or signal.	

Outlet Temperature Not Cold



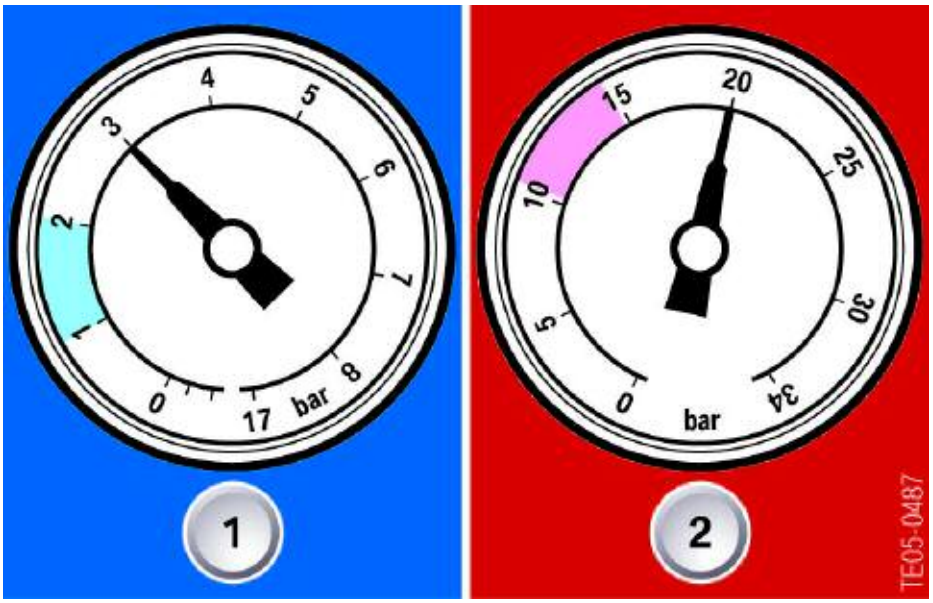
Low
to Zero psi

1 = Low pressure - too low
2 = High pressure - normal to too low

100-180 psi

Symptoms	Possible faults	Repair
• Outlet temperature not cold enough "only a little cool but not really cold".	Low refrigerant refrigerant in the system.	Evacuate system, compare amount of refrigerant removed to required system capacity. Check for leaks, correct and recycle and recharge refrigerant to specific level.
	System leaks.	Check for leaks and repair them, replace the component in question. Recycle, recharge the system to specifications and re-check.
	Failed expansion valve.	Replace expansion valve and dryer, recycle, evacuate and recharge the refrigerant to specifications and leak test.
	Defective compressor.	Replace the compressor, receiver dryer, evacuate, recharge to specifications and leak test.
	Partial blockage of the receiver dryer.	Recycle refrigerant, replace the dryer, evacuate the system, recharge to specification and leak test.

Outlet Temperature Cool but Not Cold



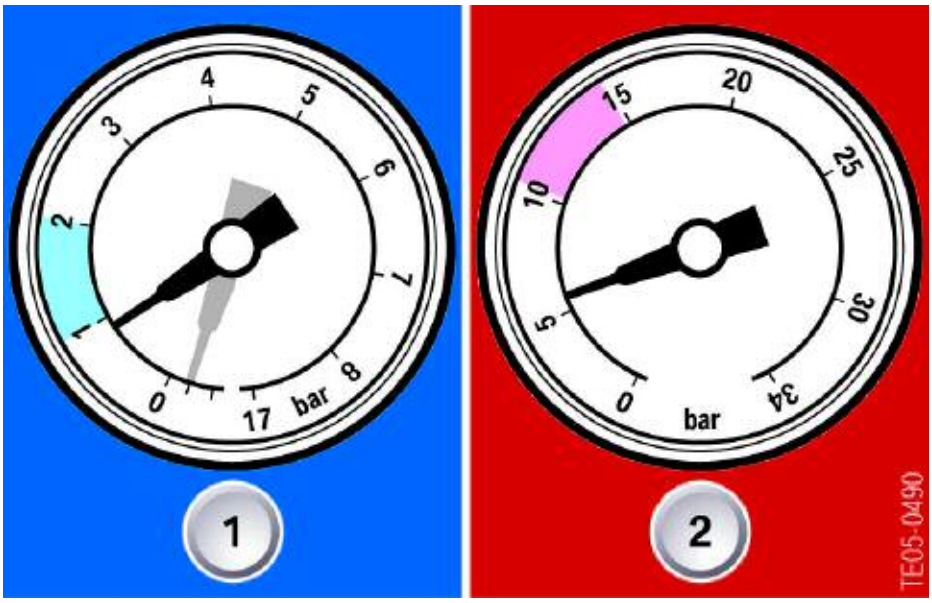
44 psi

1 = Low pressure - too high
2 = High pressure - too high

295 psi

Symptoms	Possible faults	Repair
• Outlet temperature cool but not cold. • Low side pipes hot to the touch.	Air in the system.	Leak test, replace dryer, evacuate, recharge to specifications and retest for leaks.
	Too much refrigerant in the system.	Recycle the refrigerant, evacuate the system and recharge to specifications.
	Condenser blockage/dirty fins.	Check condenser fins for debris or damage and correct.
	Condenser fan is not cooling.	Check operation of condenser fan (fuse, relay, wiring, motor, stiff movement) and correct.
	Expansion valve does not close.	Check installation and operation of temperature sensor, then replace expansion valve and dryer, Recycle, recharge and leak test.

Not Cold with Visible Icing Near TEV



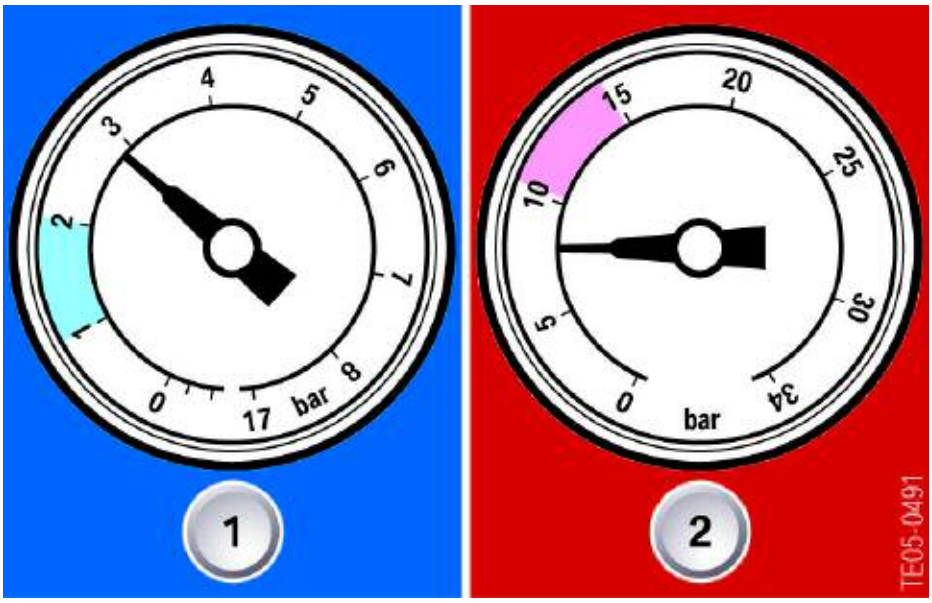
15 psi
to Vacuum

1 = Low pressure - too low
2 = High pressure - too low

80 psi

Symptoms	Possible faults	Repair
• Outlet temperature not cold enough "only a little cool and not really cold". • Low pressure may drop into vacuum range. • Visible icing on refrigerant lines from/to dryer.	Moisture in the system.	Leak test, recycle the refrigerant, replace dryer, evacuate, recharge and retest for leaks.
	Expansion valve blocked/ does not open.	Check installation and operation of temperature sensor. Isolate blockage. Recycle refrigerant, replace expansion valve and or receiver dryer. Evacuate, recharge to specifications and leak test.
	Filter dryer clogged, acts as throttle, refrigerant expands in line before expansion valve.	

Not Cold with Loud Compressor Operation



44 psi

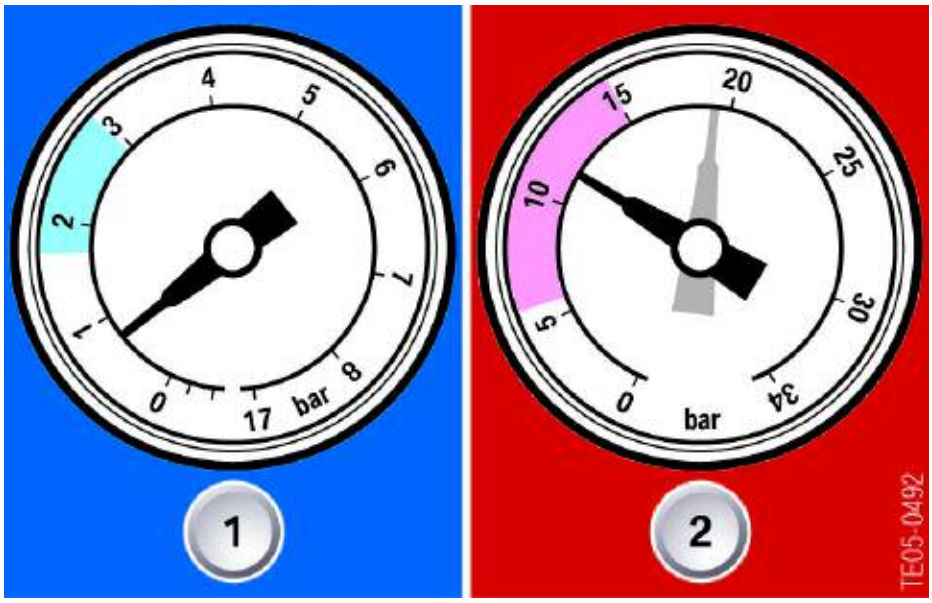
1 = Low pressure - too high
2 = High pressure - too low

100 psi

Symptoms	Possible faults	Repair
• Outlet temperature insufficiently cold "not cold enough". • Compressor is loud. • Reduced compressor output.	Compressor drive belt slipping.	Check for correct tension of drive belt and replace belt if necessary.
	Magnetic clutch of compressor defective or incorrectly set air gap/clearance.	Check operation of magnetic clutch, temperature/pressure switches, wiring, fuse / relay, control unit), adjust air gap if necessary.
	Compressor may be mechanically defective.	Replace compressor, charge the system to specifications and check for proper operation.

Note: If metal chips are found, clean entire system (e.g. blow out with pure nitrogen!) and replace dryer.

Not Cold with Visible Icing Near Dryer



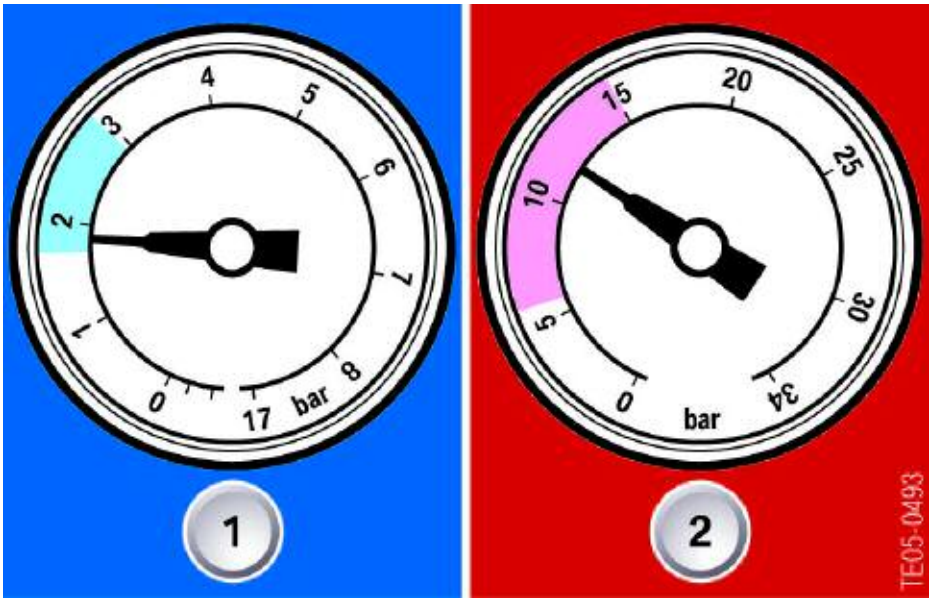
12-15 psi

1 = Low pressure - too low
2 = High pressure - normal to high

180-290 psi

Symptoms	Possible faults	Repair
• Poor or no cooling performance. • Visible condensation or icing on lines or on component.	Blockage on high pressure side, generally in dryer.	Isolate the blockage, recycle the refrigerant. Locate and repair blockage, replace the dryer, recharge to specifications, check for leaks and verify systems operation.

Not Cold with Compressor Frequent Cycling



28 psi

1 = Low pressure - normal
2 = High pressure - normal

180 psi

Symptoms	Possible faults	Repair
• Outlet temperature is not cold enough ("only a little cool but not cold enough"). • Frequent compressor switch-on cycles (short operation and short cut-out times).	Temperature sensor for evaporator is defective switches incorrectly.	Check evaporator temperature sensor. Verify electrical connection and replace if necessary.

Condenser Service

The procedure in the condenser is divided into three operations.
In the first stage, the hot gaseous refrigerant at a temperature of about 60 to120°C coming from the compressor at a pressure of 10 to 25 bar gives off its superheat to the outside air. The actual condensation takes place in the second phase where the refrigerant has lost so much energy that it becomes liquid. In the third phase, further energy is taken from the now liquid refrigerant. This state is referred to as refrigerant sub-cooling. This phase also makes sure that no gas bubbles can form on the refrigerant's way to the expansion valve. The sub-cooling takes more heat away from the refrigerant than is necessary for actual condensation. The sub-cooled refrigerant in the evaporator can absorb a larger quantity of heat and thus increase the refrigerating capacity of the system. The auxiliary fan arranged directly before the condenser ensures an effective supply of cooling air. The refrigerant remains in the condenser at a high pressure of approx. 10-25 bar. Approximately 80-90% of the condenser is used in the actual condensation process where a temperature drop of 30 to 40°C occurs.

The following points must be observed when working on the condenser:

- The distance between the condenser and vehicle radiator must be as large as possible.
- The condenser fins must not be bent or dirty.
- Ensure the auxiliary fan is operating correctly.
- A soiled condenser results in poor condensation and unnecessarily high operating pressures.

Note: The sub-cooling of the refrigerant in the condenser enhances the efficiency of the air conditioning system.

Evaporator Service

The evaporator functions as a heat exchanger in that thermal energy is taken externally from the air and given off internally to the refrigerant. The most important factor is the energy absorption by the refrigerant during the transition from the liquid to the gaseous state. This transition requires a great deal of energy in the form of heat which is taken from the air blown through the system of fins. The refrigerant cools down greatly while the injection procedure ensures the pressure drops from 10-20 bar. to about 2 bar. The refrigerant is evaporated at low pressure by the heat delivered from the passenger compartment with the use of a blower fan.

The following points must be observed when working on the evaporator:

- The evaporator fins must not be dirty or bent. This would result in the growth of bacteria and odor.
- The evaporator fins must not ice up. If the evaporator does ice up, the fault will be in the area of the evaporator temperature sensor. This situation may result in compressor damage.
- The micro filter change intervals must be maintained to insure adequate air flow.
- The condensation water drain must not be clogged and water must drain off freely.
- The evaporator temperature sensor must be installed correctly.

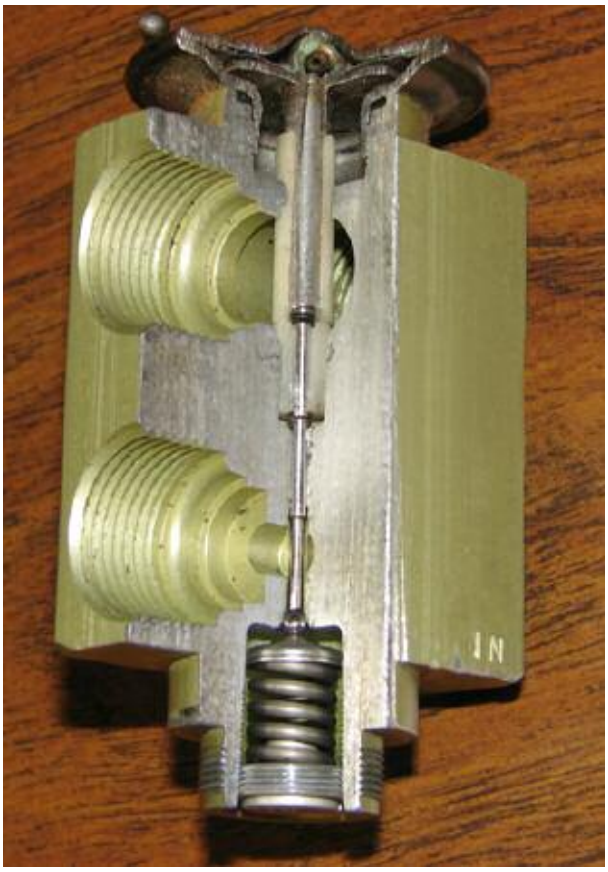
Note: To treat bacteria and odor complaints, a special cleaning and treatment procedures must be followed. SI 64 04 03 “A/C System Musty Odor” can be found in TIS.

Expansion Valve Service

A block-valve design of expansion valve is used on current BMW A/C systems. The refrigerant enters at the upper right inlet. At the left of the valve there is a capillary tube filled with an inert gas that senses the temperature of the air coming into the housing from the plenum.

When the air temperature in the plenum rises, the pressure in the capillary tube increases. This pushes down on a diaphragm and pushrod assembly, which increases the size of the orifice opening, allowing more refrigerant into the evaporator and providing more cooling.

When plenum temperature falls, the pressure in the capillary tube falls. The spring pushes up on the pushrod, making the orifice opening smaller; less refrigerant is allowed into the evaporator, allowing less cooling.
Refrigerant from the outlet of the evaporator passes through the bottom left opening of the block valve.



When the pressure at the evaporator outlet is high, this increases the pressure needed by the capillary tube to open the valve. Less refrigerant is provided to the evaporator (to prevent the evaporator from being flooded).

When pressure at the outlet end of the evaporator is lower, less pressure is exerted on the bottom of the diaphragm. The diaphragm pushes down on the pushrod, allowing more refrigerant into the evaporator.

The following points must be observed when working on the expansion valve:

- Very little refrigerant flow through the evaporator will result in poor AC output.
- Too much refrigerant flow will flood the evaporator and cause possible compressor damage.
- The setting of the expansion valve must not be adjusted or varied (except for instructions in the Service Information).
- The expansion valve must not be repaired.
- Seals must be replaced every time the pipes and hoses are released.
- It is imperative that an A/C system being serviced be evacuated for a minimum of 30 minutes or more in order to remove any possible moisture trapped within.

Note: If moisture gets into this system, it may freeze and clog the expansion valve. The A/C system may operate normally for a while, then stop cooling. Then, as system temperature increases, the ice melts. The system works again for a while, until moisture freeze-up causes it to stop again.

Compressor Service

The function of the compressor is to pump the refrigerant along the system. As the gaseous refrigerant exits the evaporator, it is pulled into the compressor by suction where it is compressed and superheater and then pumped along to the condenser. Liquid refrigerant in the compressor causes noise complaints and internal damage. There are currently three methods of compressor control and two types of compressors depending on the vehicle or equipment option. (See Compressor Operation)

Typical compressor service points to remember:

- When troubleshooting a noisy compressor complaint, make sure the noise is present only when the clutch is engaged.
- If it is present when the clutch is not engaged, remove the compressor drive belt and check again.
- If the noise continues, it is not related to the compressor.
- If removing the drive belt reduces or eliminates the noise, check the torque of the compressor and bracket mounting bolts.

- Check the belt tension and condition, and tensioner pullies which can produce rattling noises that would sound like a defective compressor.
- A loose/slipping belt can cause noise.
- A belt that is too tight can damage the clutch/pulley bearings.
- If the compressor is noisy with the compressor clutch engaged, make sure the system is charged with the correct amount of refrigerant.
- An over-charged system can cause compressor noise.
- If the A/C system is overcharged, the liquid refrigerant entering the compressor can damage it.
- When troubleshooting a noisy compressor complaint, recover the refrigerant and recharge the system with the correct amount.
- A failed compressor must be returned with the inlet and outlet ports sealed using the plastic caps from the replacement compressor. Otherwise the “failed” compressor will be damaged by moisture, and it will be impossible for Warranty to analyze it.

Compressors with plastic pullies:

- Avoid impact on the plastic pulley (through tools, contact with base).
- Send back damaged compressors only in original packaging.

Note: It is important to perform the following running-in procedure when operating a new compressor for the first time.

Compressor Running-in Procedure

- Switch off air conditioning system.
- Set all air outlet nozzles on the instrument panel to "OFF".
- Start engine and allow idle speed to stabilize.
- Set blower capacity to min. 75% of the maximum blower capacity.
- Switch on air conditioning and allow to run for at least 2 minutes at idle speed. Risk of damage at higher speed! (Refer to BMW Diagnostic Equipment Service Functions for more detailed instructions)

Note: When replacing a compressor you must follow the instructions on refilling the refrigerant oil. For details on compressor replacement and oil capacities are found in the Operating Fluids Information in TIS.